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Solid Rocket Testing at AFRL

21 Oct 2016

Robert Antypas
AFRL/RQRO



Agenda



- **Solid Rocket Motors**
- **History of Sea Level Testing**
- **Small Component Testing**
- **Full-scale Testing**
- **Altitude Facility**
- **History of Testing**
- **Questions**

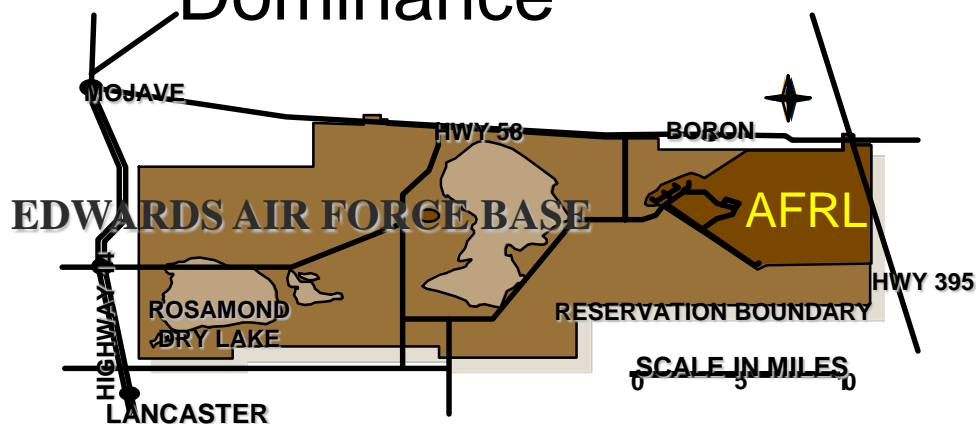


RQ-West



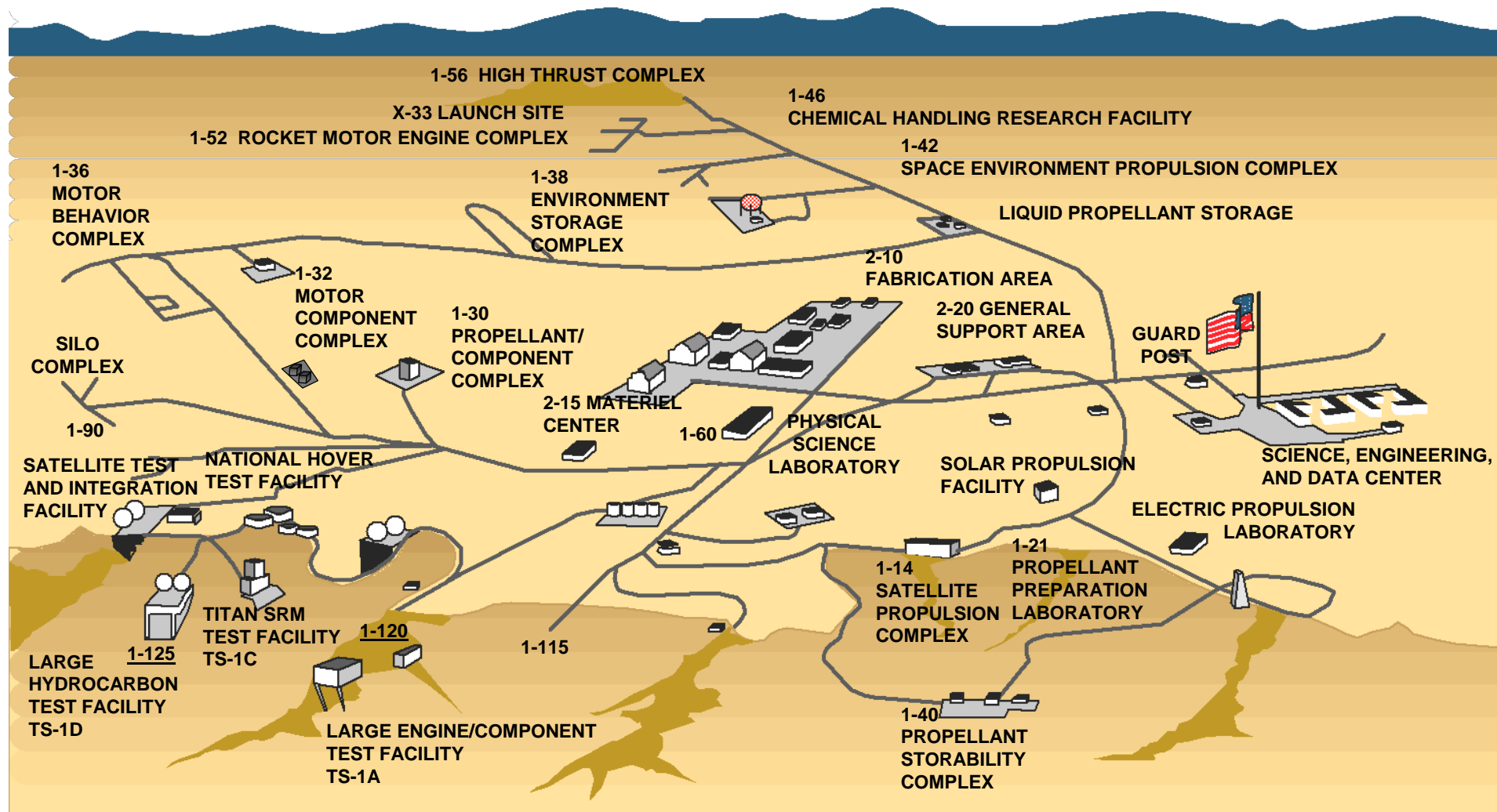
- **AFRL/RQ**
- **Aerospace Systems**
 - RQ West @ Edwards AFB
 - RQR Rocket Propulsion Division
 - Solids
 - Liquids
 - Spacecraft Propulsion
 - RQ East @ Wright-Pat AFB
 - Primarily Air Breathers

- **Mission-** Develop, Demonstrate and Deliver (3-D) game-changing rocket and in-space propulsion technology for US Air and Space Dominance



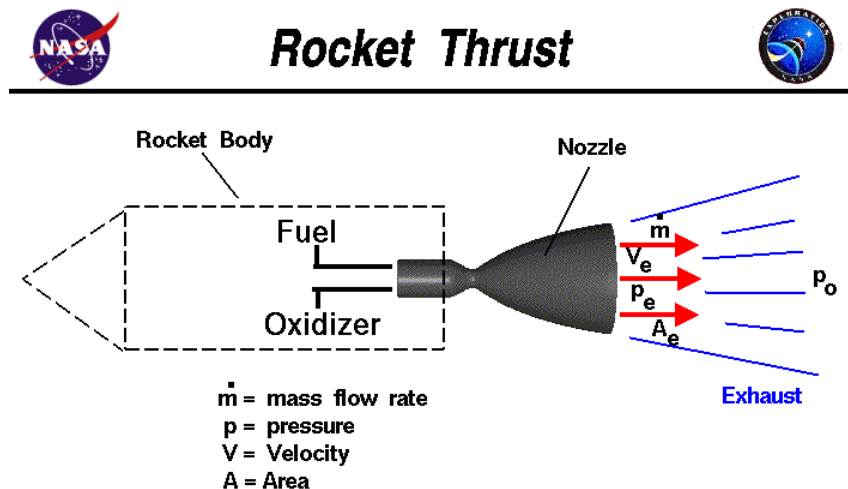


The Lab





Rocket Motors



$$\text{Thrust} = F = \dot{m} V_e + (p_e - p_o) A_e$$

- **Solid Rocket Motors**
 - Storable
 - Less moving parts
 - Lower ISP efficiency
 - Mostly non throttle-able
- **Uses**
 - ICBM's
 - MMIII
 - Peace keeper
 - Boost assist
 - Space Shuttle SRB's
 - Atlas SRM
 - 1st-4th Stages



History of Sea Level Testing @ AFRL



- 1947 Edwards AFB was selected for the location of the LAB
- 1959- Rocket scientists permanently move from WPAFB to “The Rock”
- 1958-1961 Thor IRBM testing
- 1960’s Atlas/ Titan I & II
- Minuteman I, II, III
- 1980s-1990s Titan IV
- Peacekeeper ICBM
- Atlas V booster
- Aging and surveillance of current fleets



Sub Scale Testing and Component Testing

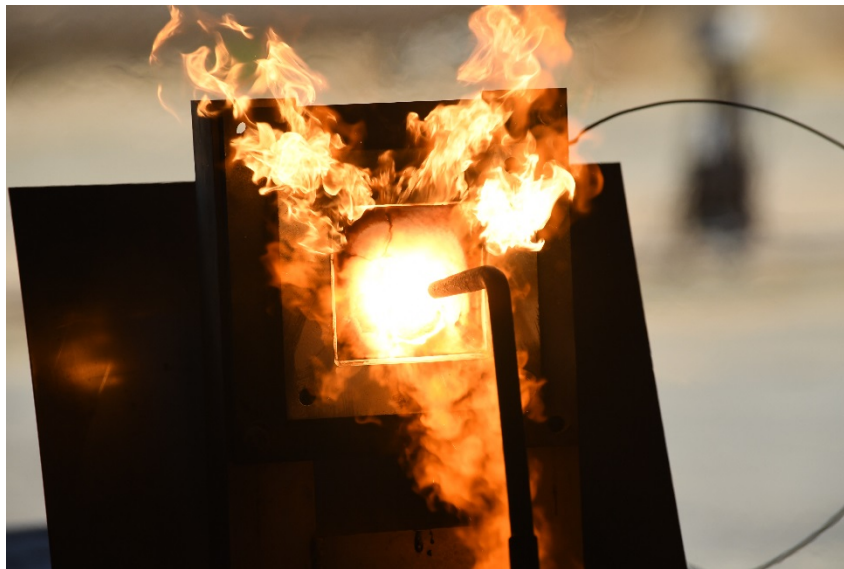


Pad 5 Inside



8/3/2016

9:00:20.962 AM



- **Components**
 - Nozzles
 - Throat materials (non eroding and non ablative)
 - Insulation materials
 - Propellant formulations
- **Sub Scale**
 - Pi k, 2.2-7 lbs of propellant
 - Pressure and burn rate evaluations



Small Scale Testing BATES



- **BATES: BALLISTIC Test Evaluation System**
- **Program started In 1959 and is still used today for propellant and insulation development testing**
- **BATES has been used in numerous tactical, strategic, and space launch propellant development programs:**
 - Sparrow
 - Sidewinder
 - Peacekeeper
 - Titan 34D SRM
 - Space Shuttle SRB
- **Two primary configurations**
 - 15#
 - 70#



BATES Video





Full-scale Testing LEO



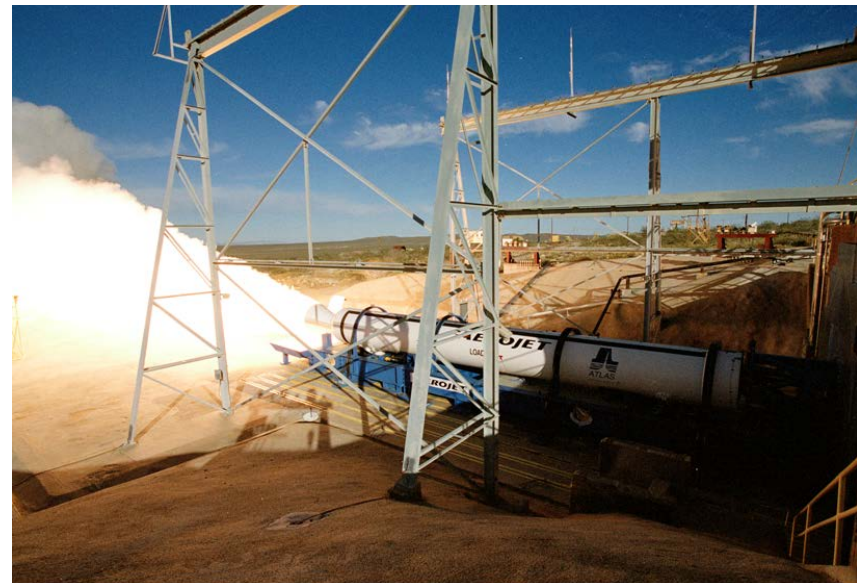
- Super Styrpi Launch Vehicle
- Hawaii Space Flight Laboratory
- Low cost access to space
- LEO-7 stage 2, tested at AFRL 14 August 2012
- LEO-46, stage 1, tested AFRL 8 August 2014



Full-scale Testing Atlas 5



- **Full Scale Atlas V Solid Rocket Booster Test at Area 1-32 Pad 2 On 24 Feb 2014**
- **Verify Material Modifications are functional and Qualify Them for Production and Flight**





Videos

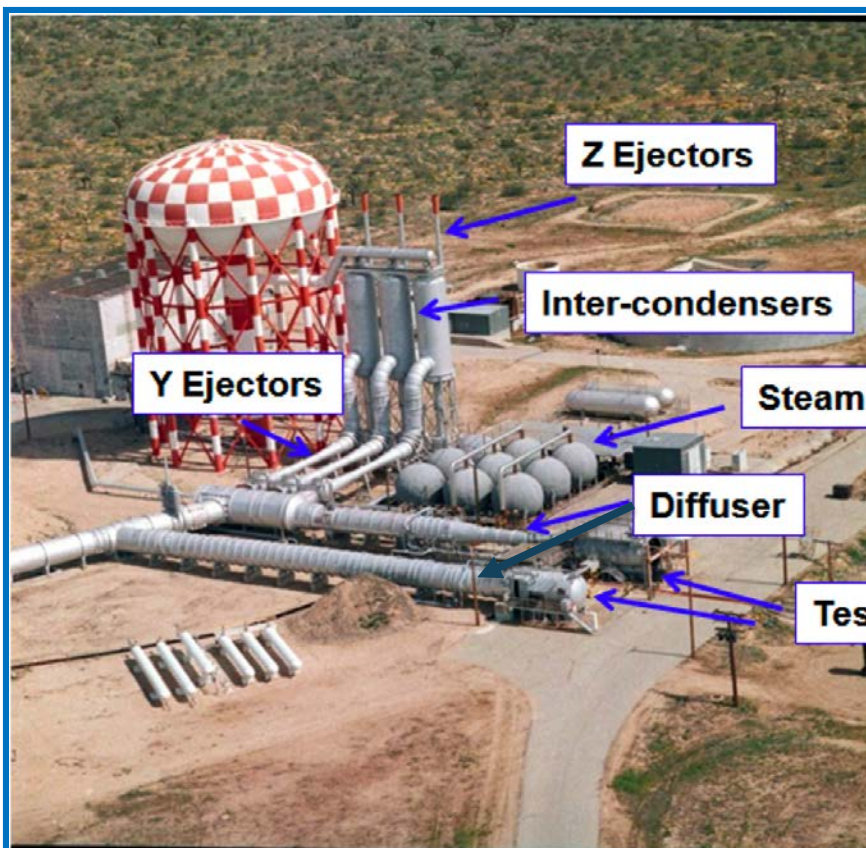


- **Atlas: Public
Release # 2014-065**
- **Leo 7: Public
Release #377ABW-
2012-1393**
- **Leo 46: Public
Release AR# 029-14**
- **TAM:**





Altitude Facility

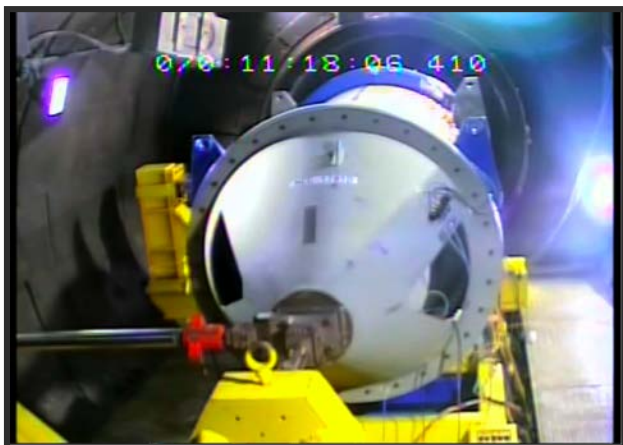


- 3 Test Positions
- 110K-ft Altitude
- 50K-lbf Thrust

-Distribution A: Approved for Public Release; Distribution Unlimited. PA#16492



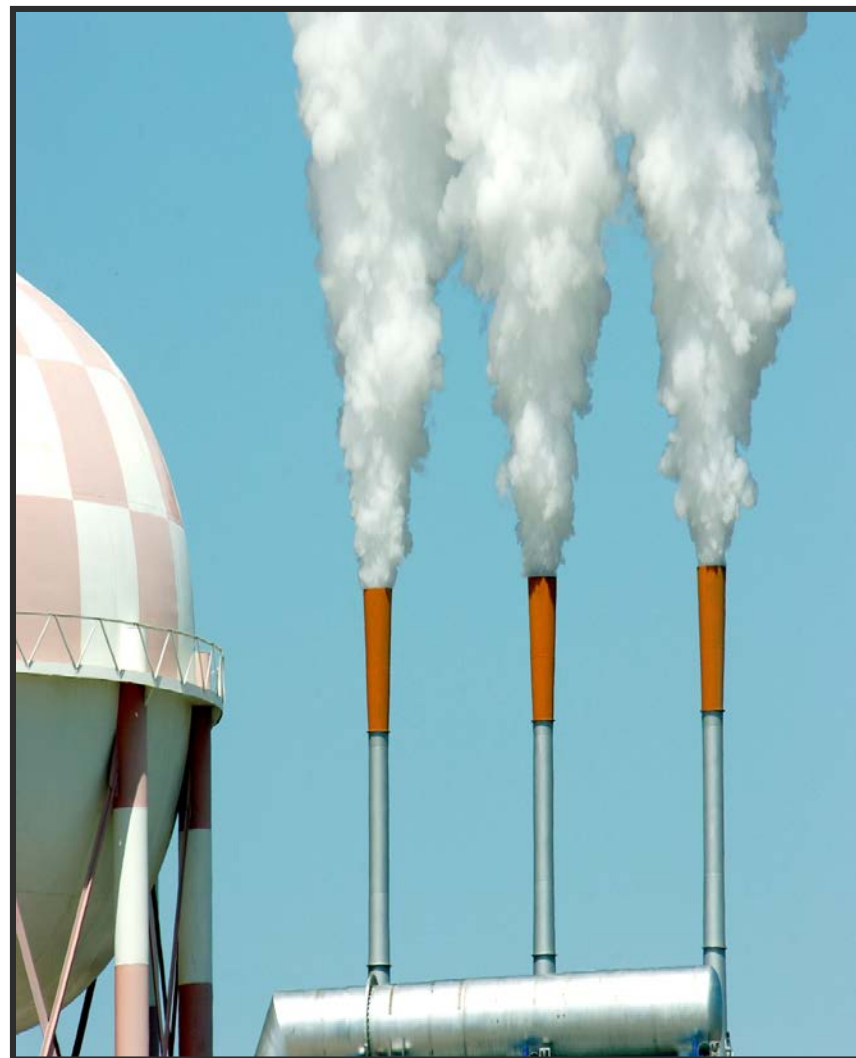
Questions



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1-42 Steam Run

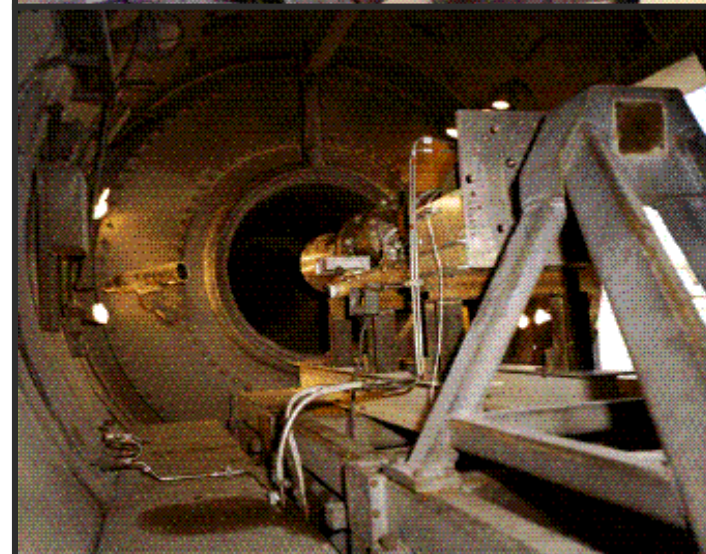
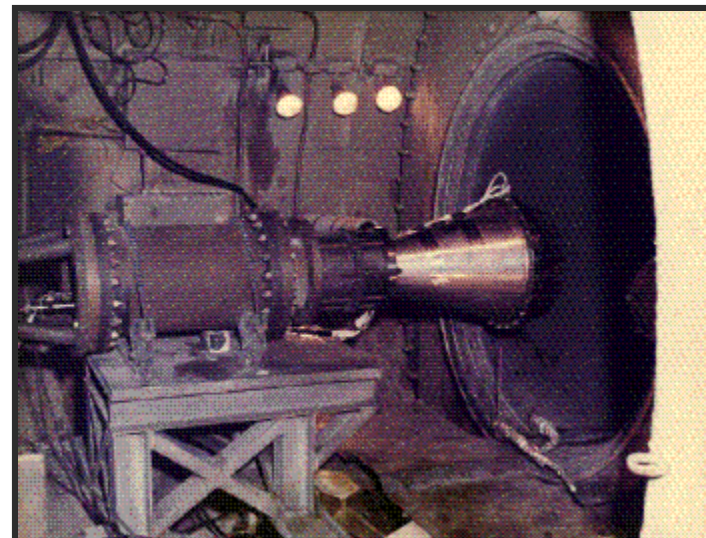




History of Altitude Testing @ AFRL

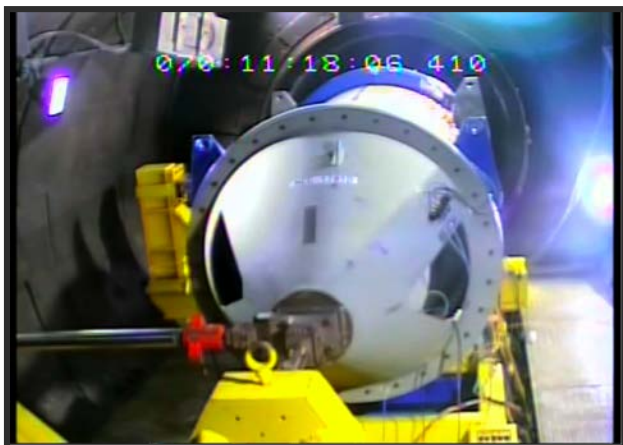


- Originally built in the 1960's for development of 2nd & 3rd stage ICBMs
- Portions of the stand were deactivated in the 1970's & 1980's
- In 1993, the stand was shutdown and left inactive
- In 1997, one ejector string was re-activated to test the Navy's Third Stage Rocket Motor
- In Oct 2007, an 18 month refurbishment effort began to re-activate all 3 ejector strings





Questions



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